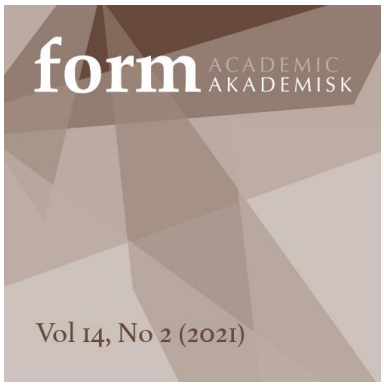

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Video Article

Between Hemse and Mästermyr

Craft interpretations of two archaeological findings from Gotland

ABSTRACT
The distance between Hemse church and the fields of Mästermyr on the Swedish Island of Gotland is about eight kilometers. The distance or rather the proximity between these two places is given importance in this filmed research article. In the 1930s, a farmer found a wooden chest in Mästermyr containing hundreds of forged tools and other artefacts. During a restoration of the Romanesque Hemse church in the 1890s, reused parts of a stave church were discovered in the wooden floor. The hypothetical question that is investigated in this study is whether the tools from Mästermyr were used in the construction of Hemse stave church in the early 1100's? This filmed article analyzes and compares the traces of toolmarks in Hemse stave church and the woodworking tools from the Märstermyr finding. Through a forensic examination involving 3D scanning with structured light, 3D printing and reconstruction of tools and woodworking procedures, it is revealed that several toolmarks in the stave church correspond to the characteristics of woodworking tools in the Mästermyr find. The tool's shape, dimensions and mode of operation are traced in its negative imprint in the stave church's oak wood.

Keywords:
Stave church, woodworking tools, craft research, reconstruction, digital documentation

INTRODUCTION

The distance between Hemse church and the fields of Mästermyr on the Swedish Island of Gotland is about eight kilometers. The distance or rather the proximity between these two places is given importance in this filmed research article. In the 1930s, a farmer found a wooden chest in Mästermyr containing hundreds of forged tools and other artefacts. During a restoration of the Romanesque Hemse church in the 1890s, reused parts of a stave church were discovered in the wooden floor. The hypothetical question that is investigated in this study is whether the tools from Mästermyr were used in the construction of Hemse stave church in the early 1100's?

These two archaeological remains are included in the Swedish History Museum's basic exhibition and have been object to extensive research. The forged tools and artefacts from Mästermyr have been documented and investigated through archaeology (Arwidsson & Berg 1983; Trotzig 2014; Thålin-Bergman 1983; 1992), ethnology (Berg 1983), geology (Lundqvist 1983) and metallurgy (Modin 1983). Hemse stave church is considered as the most complete remain of a Swedish early medieval stave church and has therefore been described and analyzed in previous research (Ekhoff 1914-16, Boëtius 1931, Rausing 1968, Lagerlöf & Stolt 1969, Haugli 1976, Lagerlöf & Svanström 1991, Anker 1999, Ahrens 2001). The craftsmanship and making procedures have been less researched (Sjöholm 2012; Almevik & Westin 2017), but the hypothesis of a possible correspondence between those archaeological remains has never been investigated.

This research analyzes and compares the traces of toolmarks in Hemse stave church and the woodworking tools from the Märstermyr finding. Through a forensic examination involving 3D scanning with structured light, 3D printing and reconstruction of tools and woodworking procedures,' it is revealed that several toolmarks in the stave church correspond to the characteristics of woodworking tools in the Mästermyr find. The tool's shape, dimensions and modus operandi are traced in its negative imprint in the stave church's oak wood. The research sets off from the hypothesis whether these two archaeological findings, closely connected in time and space, may have a direct connection through the procedures of making.

The research is presented by a film article. The written abstract is a complement to the film and the two medias form a unity of the research communication. The written text provides the meta narrative to the research context and methodology, while the film captures the motion and visual aspects of the observations and interpretations to underpin the results and the conclusion. The text cares particularly for the system of references to sources and previous research. The in-deep forensic interpretation of the primary sources has also been separately published (Almevik, Pärmsten & Sjöholm 2020). The film evolves around the reconstruction of one original wall-stave from Hemse stave church, with a focus on the woodworking procedures and uses of reconstructed tools of the Mästermyr finding. The film is vital to the deduction of our hypothesis, about the connection between these remains, without which the reality of making is reduced to unanimated forms of materials, tools, imprints, and traces. The film transfers the craft as a way to communicate the research, following the epistemological premise as phrased by Tim Ingold, that "we can tell of what we know through practice and experience, precisely because telling is itself a modality of performance that abhors articulation and specification" (Ingold 2013:109). The film also provides a methodological record on how craft is used instrumentally as part of the research method.

The film (figure 1) is about 30 minutes long, and starts with a visit to the sites in Mästermyr and Hemse. The research process is briefly outlined, showing the examination and documentation of the archaeological remains in place at the Swedish history museum in Stockholm. The main observations from the 'forensic' investigation are presented through animations of the digital documentation. The reconstructive forging of the tools is not given any deeper presentation in this film. The main chapter is instead the reconstructive experiments in woodworking, performed in a forest in Gröttlingbo not far from Hemse.

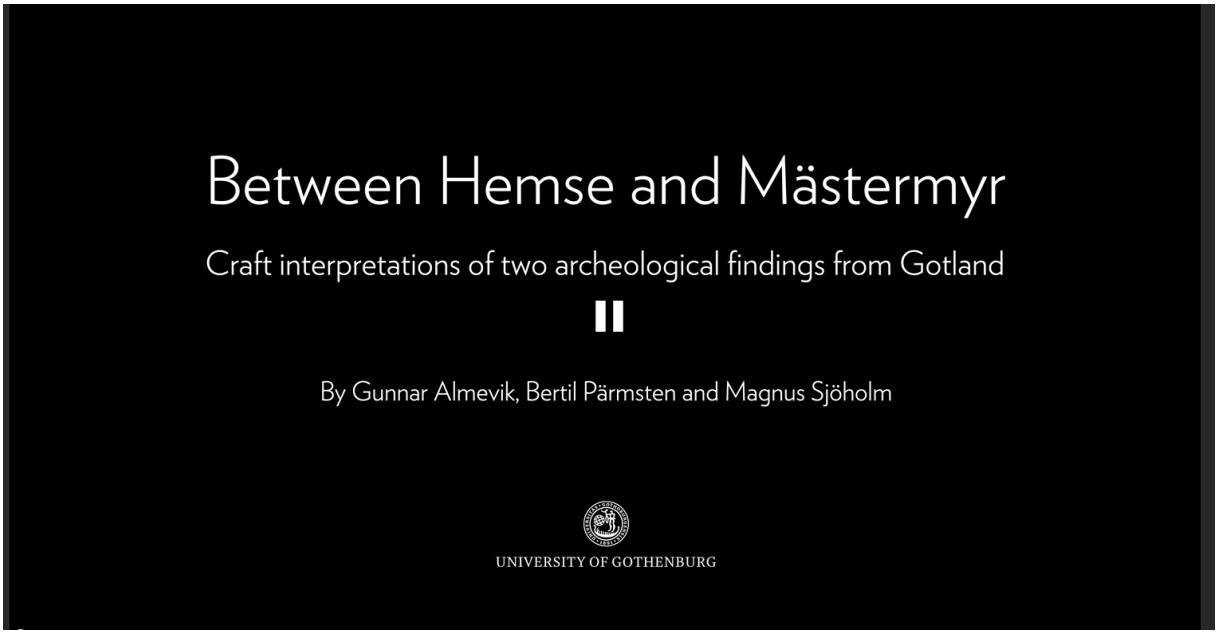

FIGURE 1. The film is about 30 minutes long, and starts with a visit to the sites in Mästermyr and Hemse. To watch the video click the picture

The research provides new evidence and information to these particular archaeological findings. The research also contributes to a general methodology for the craft sciences in combining digital technology and reconstructive craft experiments to disclose the often disregarded histories of making (Ingold 2013). Furthermore, we hope to provide an example and open the discussion on the filmed research article as a non-traditional research output.

New perspectives on old archaeological material

The farmer Hugo Kraft encountered a wooden chest of forged objects when he plowed up arable land in the property Sproge Mästermyr 1:8 (FMIS Sproge 113:1) between Silte and Sproge churches. It was in October 1936. The ground had been ditched in the early 1900s and was previously Eske swamp. In all 133 objects were found in the coffin. The Mästermyr find is stored at the Swedish History Museum and have been registered with inventory number SHM 21592 and with sub-numbers 1-133. A large part of the find is included in the exhibition "They call us Vikings". The wood-working tools have previously been interpreted in relation to boat-building and fine carpentry, based on how similar tools are used in traditional crafts today (Arwidsson & Berg 1983). However, there are traces in the remains of Hemse stave church of tools with the same measures and modus operandi. Possibly, boats and stave churches were by the same craftsmen in Early Medieval times on Gotland, or they used the same set of tools in making these different artefacts.

In 1896, the contractor Nils Pettersson called for the Swedish History Museum's attention when he during a restoration of the Romanesque stone church in Hemse found parts of a stave church reused as floor tiles. The very next day the conservator Emil Ekhoff traveled to Gotland to collect the find and bring it to Stockholm. The discovery of Hemse was important at the time, providing new information to a prestigious research field with few sources of knowledge. When Emil Ekhoff published his opus Swedish Stave Churches in 1914–16, Hemse was brought to the fore as the main example. The Swedish History Museum's artist Olof Sörling provided detailed documentation drawings, and a reconstruction that has been frequently reproduced in succeeding research to illustrate a 'proper' Swedish stave church.

In numbers, most building material are wall staves but there are also four full-length sills, two wall plates, boards, a column capital, a roof ornament and fragments of a decorative portal in the 'Urnes style'. The majority of the material is made of oak. With the measures of the preserved sills, the church's plan can be asserted to a rectangular nave of 7.85 x 5.30 meters and chances with a length of 3.40 meters. A total of 43 wall staves are preserved, constituting half of the staves that should have been included in the original design. Each side of the stave has grooves with place for a lath to interconnect the staves in the wall. The staves probably clung to the slanting cut in the sill and continued down the gutter in the ground. The stave church remain has previously been investigated with particular interest for the building's construction and transformation. Recently, the sensuous aspects of the stave church as a whole have also been object to research (Almevik & Westin 2017; Almevik 2019) but the craftsmanship with acknowledgment of the Mästermyr find has not been investigated before.

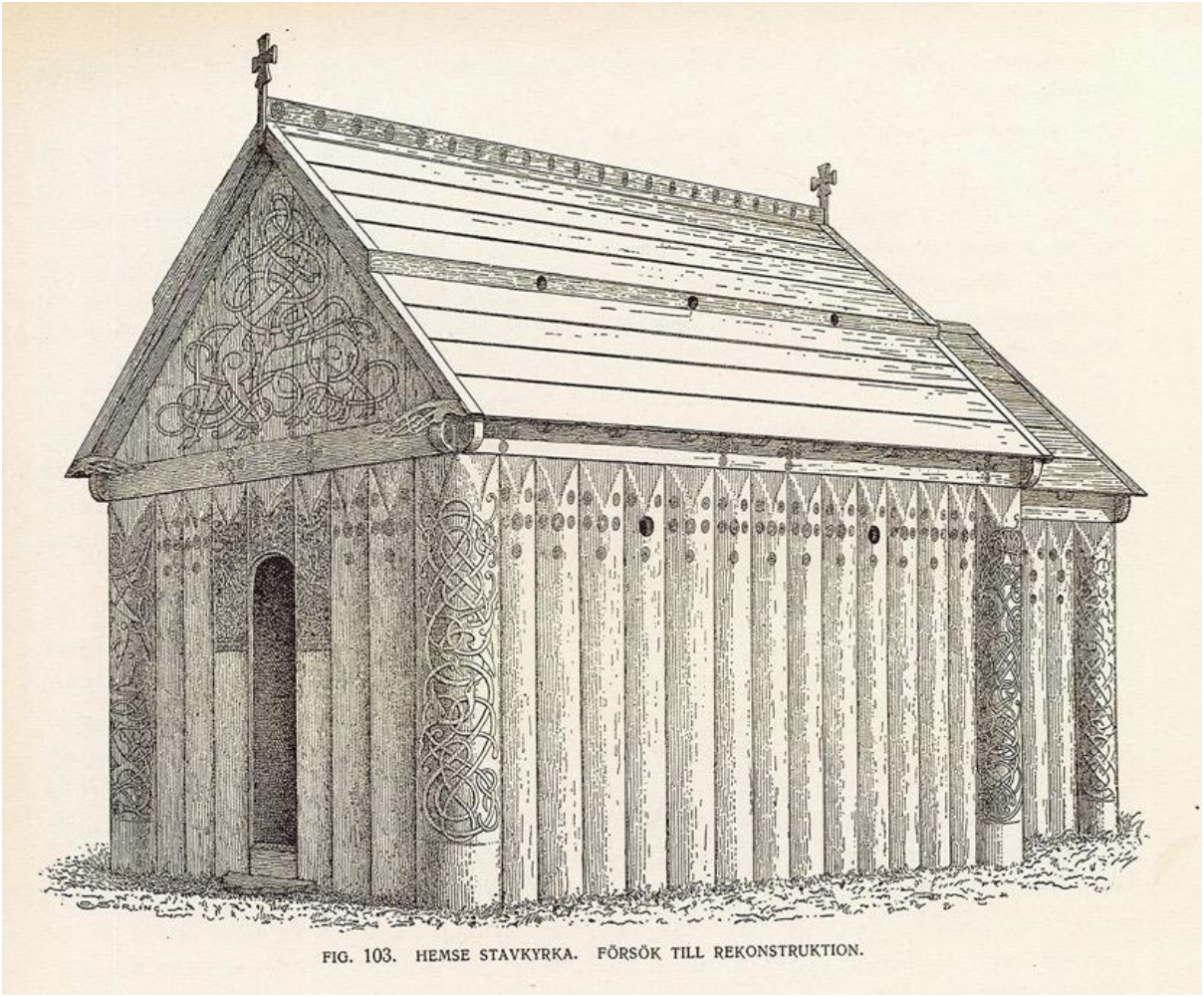

FIGURE 2. Emil Eckhoffs and Olof Sörlings reconstruction of Hemse stave church from 1913-16.

A forensic approach in craft research

The research approach involves an in-depth investigation of tools and tool-marks as well as reconstructive experimentation of historic craft procedures. The analytical focus of the study oscillates between the properties of the physical source material, the observations and affordances from the reconstructive craft experiments, and the properties of the physical results of the experiments. The investigation of the sources, the historic tools and building elements, seeks to interpret properties

related to the historic craftsmanship. Through reconstruction, the objects are brought back to a context of action from which they have been disconnected by musealization and heritagization. The practice may reveal connections and explanations that are not easily disclosed through distal theoretical thinking.

The stave church material from Hemse and the tool-chest from Mästermyr have been studied in its entirety, after which a selection of items has been made where we have identified a connection. In all 58 of the originally 67 pieces of Hemse stave church has been identified and documented in 3D by photogrammetric triangulation, also named structure from motion (SfM), with the software Agisoft Metashape (see 3D collection at SketchFab). The sills (SHM 10232:1-4), the wall plates (SHM 10232:7-8) and two wall staves (SHM 10232:16 and 43) from the stave church, and ten woodworking tools from the Mästermyr find have been documented in 3D with a structured light scanner; a Shining 3D's scanner EinScan Pro 2x Plus. The tools that have been investigated and reconstructed in this study include a knife (SHM 21592:39), a saw (SHM 21592:41), a drill (SHM 21592:50), a moulding iron (SHM 21592:57), two draw-irons (SHM 21592:54-55), two axes (SHM 21592:61 and 62) and two adzes (SHM 21592:63-64).

There are two motives for making a digital documentation in 3D. First, these objects are difficult to study on site for a long time because they are constituent elements of an ongoing exhibition. The stave church material that is not on display is bulky and not easily managed for documentation. Through digital documentation, the time for analysis can be partially moved in time and space. Another motive for digital documentation is the possibility to print the 3D model to a physical replica that can be used in the reconstructive craft experiments. To accurately represent and measure the physical characteristics in an accessible and intelligible media is also important as evidence to sustain the rigor of the research.

The woodworking tools from the Mästermyr find have been printed in 3D, using HP's Multi Jet Fusion technology (MJF). With the 3D prints, the smith Bertil Pärmsten got access to the archaeological material through accurate representations. The 3D prints have been accessible in the smithy for comparison between replica and reconstruction throughout the process. The reconstructed tools have later been used by the carpenter Magnus Sjöholm in the reconstructive craft experiments in making a wall stave guided by the remains of Hemse stave church.

The organization of the study is driven by a research perspective which we name a forensic perspective (Almevik 2019; Almevik 2012; Almevik 2017). The word forensic is commonly associated with the use of science and technology in criminal investigations and crime scene reconstructions. The parable between investigations in history and crime is relevant, as they share methodology and both activities look for traces that can elicit information and eventually become evidence to the knowledge of a past events. In the forensic perspective, the attention is directed towards *the seemingly insignificant details* that are often ignored. Historian Carlo Ginzburg refer to a paradigm of clues, a pragmatic semiotics, when physical results of action are interpreted through a deep understanding of the nature of this action (Ginzburg 1989).

The word forensic also refers to a spatial category, the Greek *forum* where opinions and thoughts were officially presented to initiate a dialogue and exchange of ideas with others. To the forensic perspective, we also want to include the interdisciplinary collaboration and dialogic approach. An important circumstance in this research is that historians and craftsmen in both forging and woodworking conduct the research together. The craft dimension is not just about the participation of craftsmen, but rather about the systematic use of crafts as a research method. The particular contribution of the researchers, also being practitioners, is their code competence that relates to their experiential knowledge that correspond to the historic sources. In a paradigm of clues, practical skills may be turned into analytical skills. The practice operates both critical and creative in relation to previous research, not least in the basic research activity of making observations in a source material.

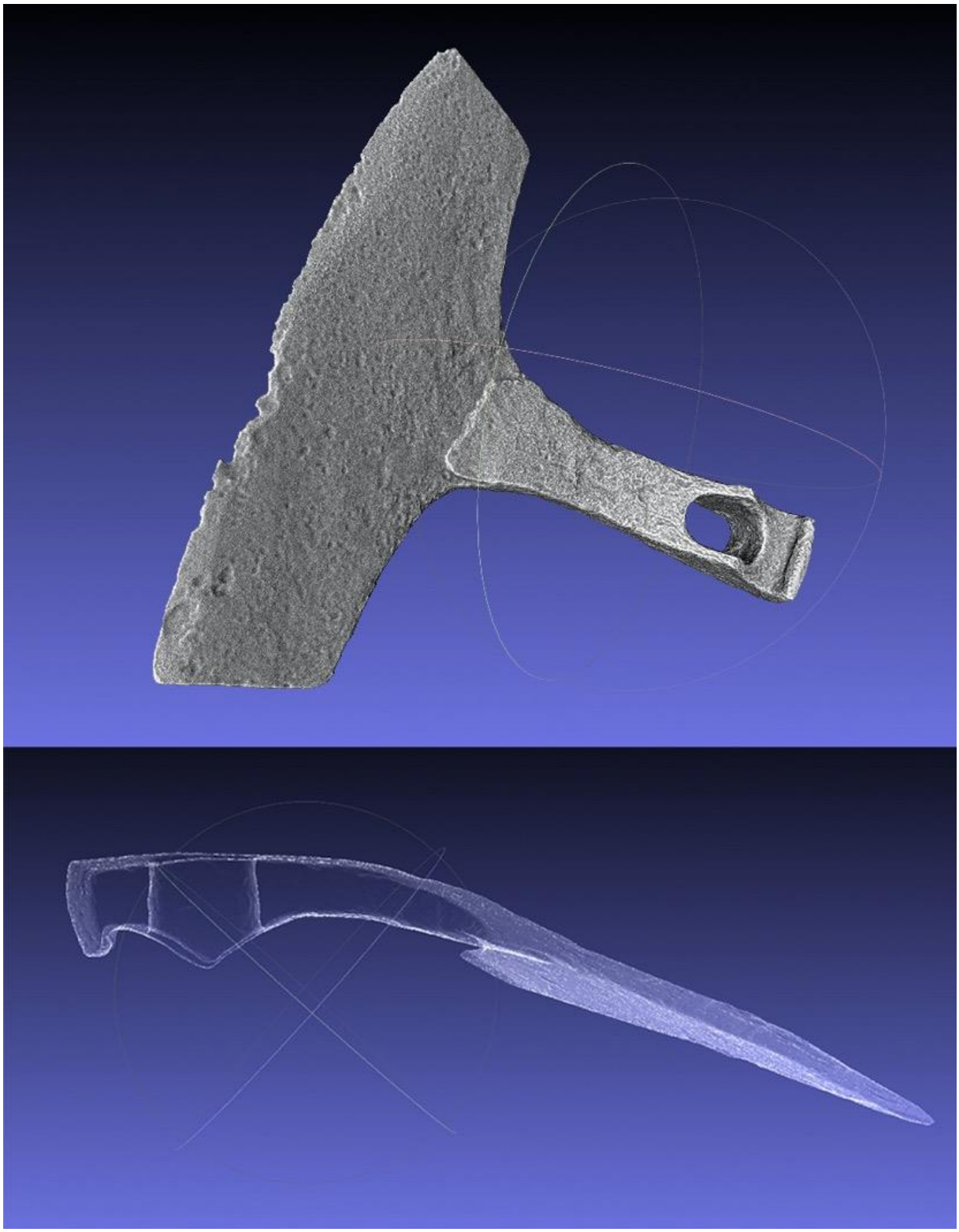

FIGURE 3-4. Renders from 3D model of the adze 21592:63 in the Mästermyr find. The documentation is made with structured light. Fig. 3 below is rendered with an x-ray shader.

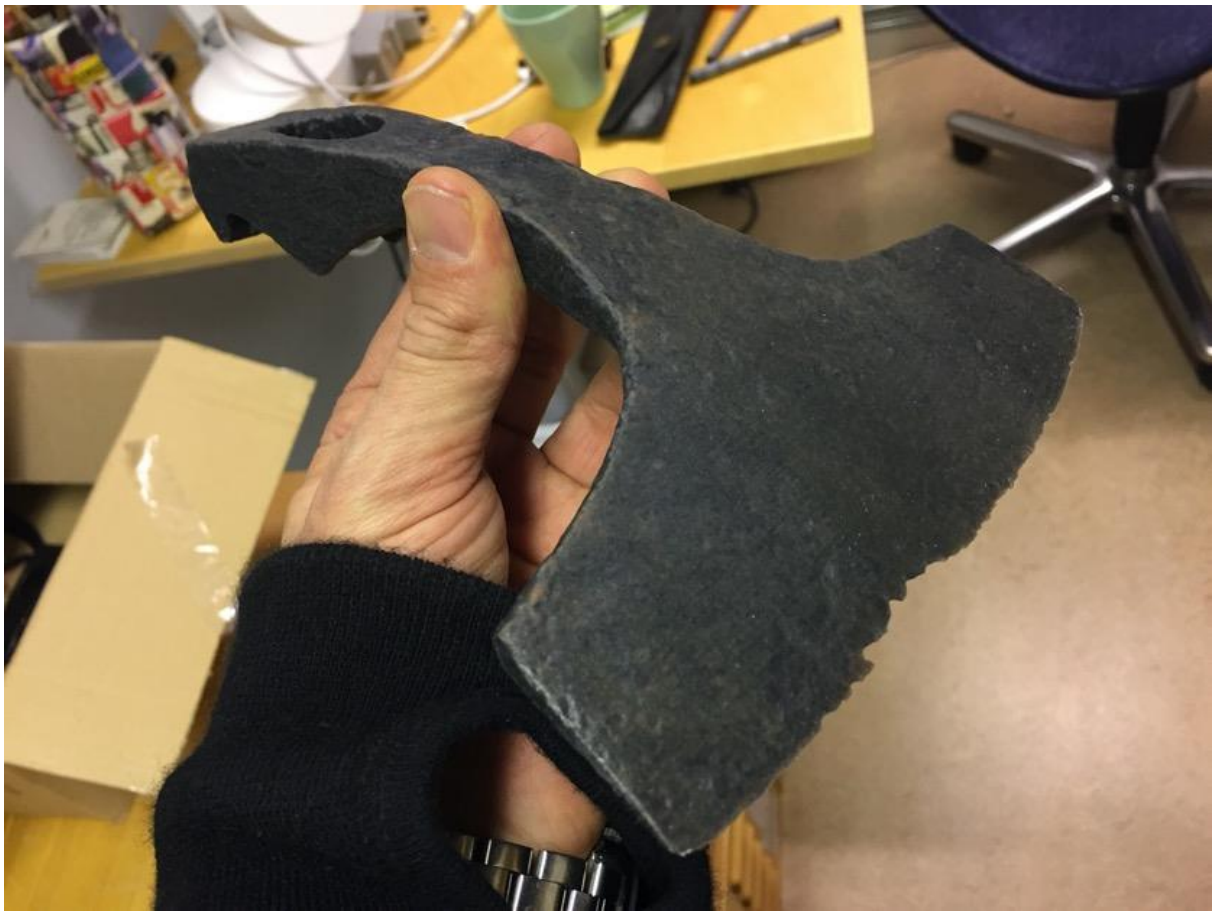

FIGURE 5. A 3D print of the adze 21592:63 in the Mästermyr find. The model is printed with MJF technology and with full color textures.

FIGURE 6. Reconstruction of one an axe using the 3D print replica of the original tool as a reference.

FIGURE 7. Reconstruction of the woodworking procedures, with the reconstructed tools.

CONCLUSIONS

The reconstructive craft experiment in this research has mainly focused on the segment-shaped wall staves. The process of converting a straight-grown oak into a wall stave comprises several working procedures, from felling and cleaving the tree, hewing and planeing flat and convex surfaces, cutting and grooving the joints and cutting and carving the decorative ornaments. In these procedures, many different tools are used for specific task. The reconstructive experiments provide opportunities to analyze the correspondence between the tools' properties, their modus operandi and the materialized results. Is it possible to infer the modus operandi from the traces, for instance to read the functional use of a wood working tool for grooving, planeing, cutting, cleaving or sawing by the marks it leaves in the wood. Is it also possible to trace the movement and direction in operating the tool, and measuring the properties, the length, depth and radius of the cutting edge of the tool as well as the traces in wood.

The discoveries in this research identifies traces in sills, wall-plates and wall staves of a forest or felling axe similar to the Mästermyr SHM 21592:61. There are significant traces from the procedures to make perpendicular cuts in the stem to facilitate the hewing. There are also traces from the same type of axe in cutting of notches and ends of the wood. There are traces from different axes but some traces measuring 65-67 mm perfectly match the axe SHM 21592:61. Furthermore, the large adze Mästermyr SHM 21592:63 may have been used in the fine hewing or planeing of the wall-pates and the parts of the sills that were visible in the church. The surface is plane and with traces from a wide edge corresponding to this adze.

FIGURE 8. Traces on the wall-plate eventually from an adze similar to 21592:63 in the Mästermyr find.

We have eventually found the oldest trace of a sawing blade in an historic building from Scandinavia. The sides of the wall staves have been hewn with axe when they were reused as a floor in the Romanesque stone church. There are however a few staves where the edge of the wood is preserved in its original state. The edge where the staves meet was originally slanting inwards in a V-cut much alike corner timber logs. To cut the surface in this way and direct the meeting points at each side of the surface is a traditional way of joining wood. At the very edges of the staves there are also traces of sawing. The traces from the saw do not run continuously along the entire edge but in certain distances. Our hypothesis is that the joints between the effective, the teeth of the saw are angled outwards (skränkta, [swe].) in a way that is common in traditional so-called floor tile saws. The saw SHM 21592: 41 in the Mästermyr find corresponds to the traces and has all the properties related to this modus operandi.

FIGURE 9. Testing the tools and the various procedures of woodworking, and comparing the traces with the historic sources.

FIGURE 10. Traces from a saw-blade on the side edge of the wall stave SHM 10232:43.

FIGURE 11. Testing of a hypothesis of using the saw, to joining the wall staves with a tight seam.

FIGURE 12. Both the functional result and the traces indicates that the hypothesis is possible.

The most interesting matches are found at the grooves along the wall staves and the underneath the wall plates. First, a forest or felling axe like SHM 21592:61 have been used to cut up the groove in two straight parallel lines. The wider groove in the wall plate has been cut up possibly with an adze like SHM 21592:64. In the bottom of the grooves there is a significant trace of a draw-knife. The cutting edge of the draw-knife in the Mästermyr find SHM 21592:55 measures 12 mm which is exactly the same measure as the toolmark in the wood. The radius of the convex edge is similar, and there is also a salient damage in the edge of the historic tool that directly corresponds to a small ridge in the concave toolmark. Of course, the draw-knife's steel is aged and corroded, and the characteristic trace could have

been made by another draw-knife. However, there are several matches between these two archaeological finds. The possibility that it could be the very same axe, draw-knife, saw and adzes that were used when Hemse stave church was built in beginning of 1100's cannot be dismissed.

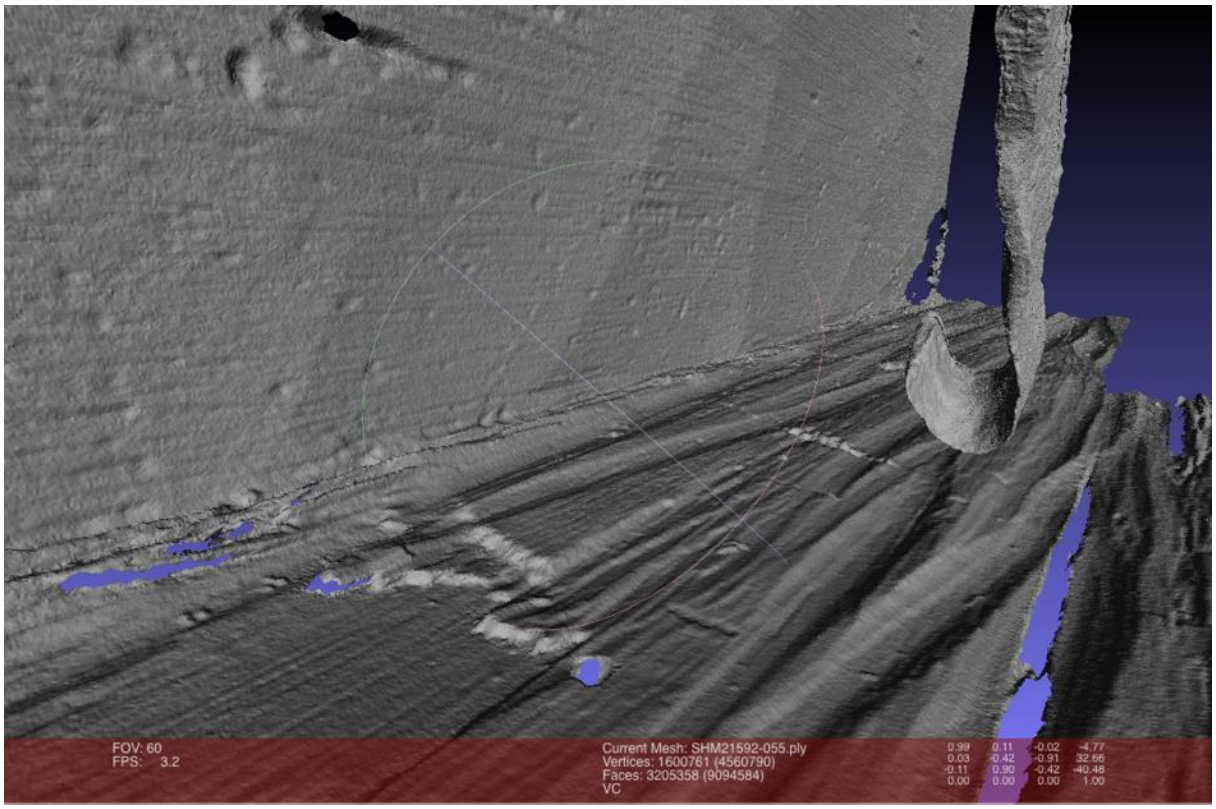

FIGURE 13. Montage of the 3D model of the draw-knife SHM 21592:55 and the groove in the wall-plate SHM 10232:8.

FIGURE 14. The reconstruction shows a functional procedure and result in traces very similar as in the archaeological remain.

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